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THE SCOPE AND PRESENT POSITION OF BIO-CHEMISTRY.

BY ALBERT MATHEWS.

The practical value of pure science is now so generally recognized that no excuse need be given for a plea on behalf of a neglected department. Especially is this true of a department which so closely concerns our bodily welfare as does physiological, or bio-, chemistry. This science has not received in America that recognition and support which its importance as an applied or pure science would warrant. This may be due, in part, at least, to a failure to realize that to biochemistry belong problems outside the scope of any other science; it may, therefore, not be out of place to indicate briefly what some of these problems are, and to what position, in the world at large, this new science has now attained.

Although it is impossible to define sharply the limits of a science it may be said, in a general way, that to biochemistry belong all problems of the chemistry of living matter, or of the chemistry of metabolism. It is thus the complement of the group of sciences treating of the forms and relationships of organisms, botany and zoology, and of the mechanics of organisms, or physiology proper. Touching each of these sciences closely, it receives from each special problems for solution.

Among the more important problems of plant biochemistry are the chemical nature of chlorophyll, the nature and manner of action of the starch-forming substance, the determination of the substances out of which the plant synthesizes its protoplasm, and the nature of this synthesis. In bacteriology the biochemist has a wide field for work. The isolation of the specific immunizing substance in the antitoxins of diphtheria, tetanus and other cases of artificial immunity, is a matter of great practical importance. There is pressing need of a chemical examination of the bacteria and their products, whether poisonous or not. The determination of the active substance in such bodies as the tubercle bacilli, which cause cell proliferation, is an interesting matter which might have a considerable practical value.

In physiology, biochemistry has hitherto played its chief rôle in the study of excretion and digestion. The results obtained have thrown light on the functions of many organs. An interesting question of physiology at the present time is that of the internal secretions of glands. It is becoming increasingly probable that these form an important element in the coördination of the organism, one organ or gland forming and throwing back into the blood substances essential to the life of some other organ. The determination of these substances, of such preeminent importance to the organism, is a biochemical problem. The isolation of the contractile substance in muscle, the chemical changes undergone by muscle and nerve during activity, the nature of the irritable substance of the nervous system, are puzzles which fall to the biochemist. Our knowledge of the chemical constitution of the fluids and tissues of the body in health and disease is derived from this science.

In the province of biology the ultimate aim, however distant the goal may be, is the analysis and synthesis of living matter itself. The explanation of the formation of new protoplasm will probably come from the biochemist. He must isolate and examine the various substances in the cell. That this field is full of promise is evident from the results already obtained. Morphology, too, furnishes its quota of problems. The influence of certain substances upon embryonic development is in part

chemical. We are now familiar with the progressive differentiation of organs from the egg, but of the nature of the chemical differentiation which this structural differentiation implies little is as yet known. Whether the chromatins of the cells derived from the egg are different from that of the egg-cell, and in what way, is a question of theoretical interest to be answered definitely only by biochemical research. The determination of the chemical nature of the substance causing cell division, karyokinesis, of the substances formed, and of the nature of the changes undergone, is essential to the understanding of this process. The answer to these questions may be of value in the explanation of tumors and other pathological growths involving karyokinesis.

Biochemistry has perhaps its chief practical worth in medicine. The physician it serves not only indirectly through the solution of physiological and bacteriological problems, but directly in testing the action of drugs and diets upon metabolism, and in the careful study of the urine and blood in health and disease. The physician is thus given an accurate means of diagnosis in certain diseases. An interesting result accomplished recently in this direction has been the discovery of the origin of uric acid, a substance of considerable pathological interest, in the chromatin of the cell-nuclei, and thereby a possible explanation is given of the action of quinine, antipyrin, and antifebrin, in decreasing the secretion of this substance.

Another practical biochemical problem important in medicine is the isolation from glands and other organs of their so-called "internal" secretions already mentioned. Hitherto, in treating myxœdema, goitre, or Addison's disease, by the so-called extract therapie, physicians have used either the whole substance of the thyroid, or thymus glands and the suprarenal capsules, or extracts of these organs—a process which introduces useless as well as healing matter. It would be advantageous to use the pure remedial substance alone. In one of these organs this is now possible, two biochemists having recently isolated the healing substance from the thyroid gland so that it is now prepared pure for the physician. It is not too much to hope that similar substances will be isolated from other

glands and organs, and that the physician of the future will be able partly to maintain the metabolic equilibrium of the body, or to restore that equilibrium when disturbed, by supplying the missing substances.

The composition of the yeast-cell, its metabolism when fed on different substances and under different conditions, the determination of the sugars which it will, or will not ferment, and the isolation of its special ferments, are problems important for the brewer, the winemaker and the baker.

The questions thus brifly indicated form a well-defined group. They constitute the problems of one science. Many of these problems cannot be satisfactorily dealt with either by the organic chemist alone or the physiologist alone. The biochemist needs both a theoretical and practical knowledge of animal and plant morphology and physiology, which is largely superfluous in the analysis and synthesis of the great majority of organic substances. On the other hand these problems cannot be left to the physiologist, for few physiologists have the time or opportunity to acquire the necessary chemical knowledge. Even pure physiology alone is so broad that one is rarely found thoroughly familiar with more than a portion of it.

It is for these reasons desirable that the independent position of biochemistry should be recognized, and equipment and means provided for its development. And it is an encouraging sign of the times that so eminent an organic chemist as Emil Fisher, has recently spoken strongly for the independent position of biochemistry.

In Europe, largely owing to the winning personality and untiring labors of the late Felix Hoppe-Seyler, the science is now beginning to receive recognition. The modern science of biochemistry, indeed, may be said to have been founded by this illustrious man; for, although previous to him work had been done in a biochemical direction by chemists, physiologists, agriculturists, and others, he was the first to urge the independent position of this science. An Institute and Professorship of Physiological Chemistry were established for him at Strassburg. He founded a journal in which papers treating of bio-

chemical matter could appear, and thus brought to a focus a number of lines of effort which had formerly been scattered in chemical, physiological and agricultural publications. The founding of the Strassburg Institute and Professorship was the official birth of biochemistry.

But, although great progress has been made since Hoppe-Seyler opened his first laboratory in the kitchen of the old castle in Tübingen, the position of the biochemist in Germany is still behind that in many other European countries. The Strassburg Institute remains the only purely biochemical institute in Germany. In many German universities the biochemists are nominally full professors of physiology, as in Heidelberg (Kühne), Marburg (Kossel), and Munich (Voit); in others, besides the full professor (ordinarius) of physiology there is an associate professorship (extraordinarius) in physiological chemistry. This is the case in Berlin (Thierfelder) and Breslau (Röhmann). In still others the professors of pharmacology take over the duties of the biochemist, as in Rostock (Nasse), Königsberg (Jaffé), Giessen (Gähtgens) and Halle. In Tübingen the physiological chemist is called professor of applied (angewandte) chemistry, and belongs to the philosophical faculty; in Freiburg he is professor of chemistry and belongs to the medical faculty; in Leipsic he is a privat docent (instructor) in the physiological institute. In the universities of Göttingen, Kiel and Würzburg there is no special instruction in this science. In Germany, therefore, although the science is recognized in nearly all universities, and its teachers in many cases full professors, they are generally handicapped by being required to teach chemistry, physiology, or pharmacology.

Outside of Germany the situation is generally more favorable. In Austria the universities (Prague, Vienna and Gratz) have professorships in medical chemistry. In Switzerland there are professorships of physiological chemistry in Basel (Bunge) and Berne (Drechsel). At Zürich there is none, though a good deal of work is done in the agricultural chemical laboratories. In Norway, at Christiania, there is no chair of physiological chemistry. In Russia nearly all the universities—Moscow, St. Petersburg, Warsaw, Kieff, etc.—have chairs of

physiological chemistry. In Galicia such professorships are established in the universities of Lemberg and Krakow. In Italy and France, as far as I can learn, there are no such professorships, but accurate information is lacking. In Sweden, at Upsala, the biochemist Hammarsten is Professor of Physiological and Medical Chemistry. At Stockholm there is also a professorship in this science, as well as in Lund. It all these cases, it will be understood, there are separate professorships in physiology. In England there are no professorships of biochemistry. The biochemist Halliburton is Professor of Physiology in Kings College, London. In Cambridge University, in the extensive laboratories of Professor Michael Foster, considerable space is devoted to biochemistry under the direction of Dr. Sheridan Lea.

In Germany there is one magazine, "Die Zeitschrift für Physiologioche Chemie," devoted entirely to this science. About four-fifths of the "Zeitschrift für Biologie," one-fourth of Pflüger's "Archiv für die gesammte Physiologie," nearly all of Schmiedeberg's "Archiv für experimental Pathologie u. Pharmakologie" consist of biochemical papers. Many papers also appear in Virchow's Archiv, in the Bacteriologische Centralblatt and various other scientific publications.

In England the "Journal of Physiology" contains a greater or less number of biochemical articles—but there is not in the English language any magazine devoted exclusively to this science. Nor is there any American Journal of Physiology in which biochemical papers could appear. The English Journal of Physiology is the only journal which will give physiological and biochemical papers a general circulation. It is unfortunate that so large a proportion of physiological papers from American laboratories should be driven to the German journals and language. This is the more to be regretted since the history of the Journal of Morphology teaches that an American physiological journal, publishing papers of a high class, would have an assured circulation among European scientific men.

We, in America, are in a backward condition when compared with Germany, Russia, Sweden and Switzerland. Biochemistry in America has suffered, like physiology, from being con-

fined to the medical schools. Here both have been treated too largely as applied sciences. Both would greatly profit in being taken from the medical schools and established, like physics or chemistry, in separate institutes where both the pure and applied science should be taught. The biochemical laboratory should be one of the laboratories of the university, just as the laboratory of experimental physiology, or organic chemistry. It should be in the hands of investigators, and should give instruction not only in urine analysis, but in the principles of metabolism. For the purpose of mutual helpfulness it should be in close connection with the laboratories of experimental physiology and organic chemistry. It is greatly to be hoped that the progress of this science in America may be furthered by the establishment of professorships of biochemistry and of an American Journal of Physiology and Biochemistry to provide a ready means of publication for physiological and biochemical papers.

THE POLYPHYLETIC DISPOSITION OF LICHENS.[1]

By Frederic E. Clements.

The present trend of thought upon the morphology and disposition of the lichens must be most encouraging to those, who stood at first alone, and then with ever-increasing company, for the complete acceptation of the Schwendenerian hypothesis, and of the morphologic and phylogenetic theories involved in it. Even during the present decade, botanical literature has not lacked for articles, penned chiefly by lichenologists, disproving in its entirety the algo-lichen theory, and maintaining the autonomy of the lichens, as they are pleased to term it. When the "symbiosis", "consortism," or parasitism of lichens was established beyond a doubt, and polyphylesis was postulated as a necessary consequence, the lichenographers again rose en masse, arguing and pleading for the dignity and autonomy of their group. Since the tacit and universal

[1] Read before the Botanical Seminar of the University of Nebraska. December 5, 1896.